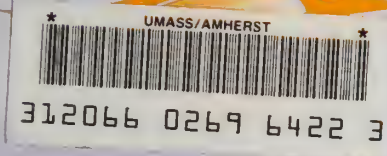


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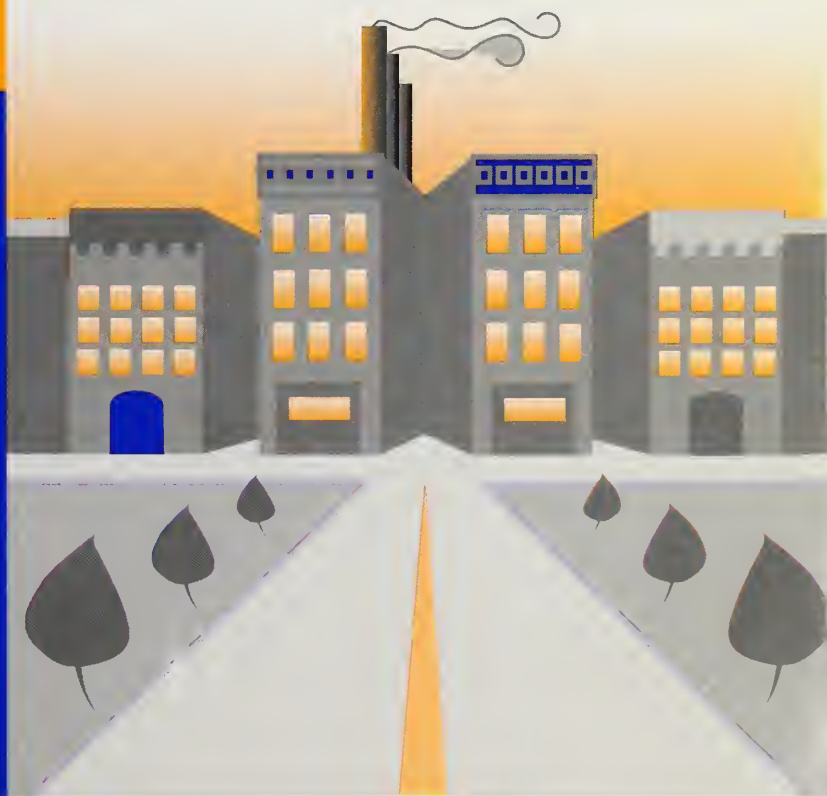
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The Massachusetts TOXICS USE REDUCTION INSTITUTE

Promoting cleaner and safer industry in Massachusetts



The TOXICS USE REDUCTION INSTITUTE was established in 1990 through the passage of the Massachusetts Toxics Use Reduction Act. This far-reaching law was enacted to promote a new “preventive approach” to environmental protection. The law required over 600 firms in Massachusetts to inventory the toxic chemicals that they manufacture, process, or otherwise use, report annually on use of the chemicals, and create a plan for reducing or eliminating their use. The Institute was established to provide the education, research, and technical support services that promote the mission of the law.

The Institute, which is often referred to simply as “TURI,” was set

up at the University of Massachusetts’ Lowell campus to take advantage of the faculty and student resources of this long-recognized technical college. TURI is part of the state’s toxics use reduction program, which is supported primarily by fees paid by Massachusetts companies that participate in the program. TURI also receives funds from other sources for research and training.



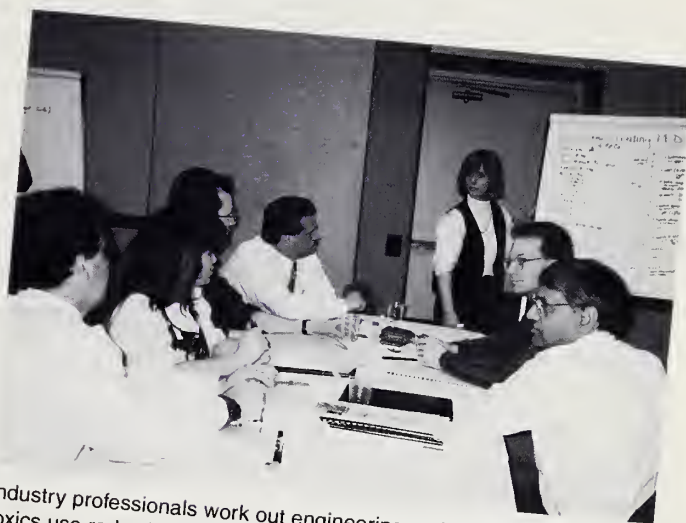
Ed Gomes, environmental manager at Tri-Star Technologies in Methuen, explains toxics use reduction (TUR) methods to an audience of TUR planners and other industry professionals during a site visit to his firm, one of the Institute's Cleaner Technology Demonstration Sites.

TURI Provides Training for Industry

Over 800 professionals from Massachusetts firms have participated in the Institute's Toxics Use Reduction Planner Course. This unique 48-hour training program was designed by the Institute staff to prepare Massachusetts professionals for toxics use reduction planning and to certify company TUR plans. The course offers training on process characterization, materials accounting, option development, financial analysis, health and safety assessment, and plan implementation.

This is an activity-based, interactive training course, with a course-long case study based on an actual Massachusetts company's success story.

In addition, the Institute offers a wide range of continuing education programs to keep toxics use reduction planners and others abreast of new developments in such areas as toxic chemical management, new production technologies, energy efficiency, and environmental management systems. Every other year the Institute convenes a two-day conference where planners learn from experts and share experiences and successes with each other. Sessions are interactive and ample time is allowed for networking and problem-solving around relevant issues.



Industry professionals work out engineering problems as part of a toxics use reduction planning exercise at one of the Institute's training sessions.

TURI Adjunct Instructors

John Burkitt, Digital Equipment Corp.
Chris Ford, Printed Circuit Corp.
Ed Gomes, Tri-Star Technologies
Tim Greiner, Greiner Environmental
Mark Griffon, University of Massachusetts
Mitchell Kennedy, Pollution Prevention Cooperative, Ltd.
Ray Lizotte, Texas Instruments
Frank Marino, Raytheon
Leland Miner, Retired Engineer, Monsanto
Joel Pointon, JRP Consulting Services
Anne Reynolds, Lucent Technologies
Mark Rossi, Massachusetts Institute of Technology
Gary W. Siegel, Goldman Environmental Consultants
Ed Surette, M/A-COM
Ken Tierney, Raytheon
Jodie Siegel, University of Massachusetts
Dick Michelsen, Monsanto
Gretchen Latowsky, John Snow Institute
Sam Perkins, Green Tech Consulting
Bob Eisengrein, Acton Citizens for Environment & Safety
Timothy Woycik, Eastern Utilities
Douglas Devries, Hyde Tool Company
Jack Bailey, Acushnet Rubber Company
Joseph Knapik, International Metal Products Corp.



At the Smith Vocational and Agricultural High School in Northampton, students learn about toxics used in metal technology applications as part of the Institute's community education grants program.

Government Agency Training at TURI

The preventive approach requires changes in both industry and government. TURI staff have facilitated and designed training courses for environmental regulators in Massachusetts.

Jody Hensley has been designing and delivering courses for agency staff for the past six years. Jody enjoys the challenge. "Government in general has a tradition of slow and incremental change," she observes. "Pollution prevention requires a fairly fundamental shift in the way one approaches environmental protection. Helping agencies with their transition from a control paradigm to preventive thinking is complex and interesting work."



TURI Promotes Education in Cleaner Production

Institute staff have initiated new environmental curricula throughout conventional education systems. The Institute sponsors workshops for high school teachers, training for vocational education instructors, and new homework modules for faculty teaching in engineering colleges. The Institute has sponsored the development of a new graduate concentration entitled "Cleaner Production and Pollution Prevention" in the School of Engineering at the University of Massachusetts Lowell.

TURI Sponsors Demonstration Programs in Cleaner Technology

To promote the transfer of cleaner technologies, the Institute launched the Demonstration Sites Program in 1995. The program promotes adoption of innovative technologies by allowing individuals and firms to observe operating TUR technologies and assess their value firsthand. Since 1995, approximately 700 representatives of industry, environmental groups, community groups, toxics use reduction planners, and technical assistance agencies visited these showcase sites. From 1993 through 1998, thirty-three Matching Grant and Demonstration Site projects were funded at Massachusetts companies, with awards totaling \$410,000.

Cleaner Technology Demonstration Sites & Matching Grants Program 1998

ACUSHNET RUBBER COMPANY, INC.,
New Bedford

ISO 14,000 Demonstration Site

ASE AMERICAS, INC., Billerica

Fluoride Ion Reduction in Photovoltaic Product Manufacture

LAB MEDICAL ENGINEERING &

MANUFACTURING, INC., North Billerica

Plasma-Based Technology for Stainless Steel Passivation

M/A-COM, A DIVISION OF AMP

INCORPORATED, Lowell

TUR Demonstration Site and Low Temperature Powder Coating Feasibility Study



The InTURn Program

Being affiliated with the University of Massachusetts Lowell's College of Engineering and working with many industry environmental professionals, the Institute made the obvious connection and created the Student InTURnship Program. Through this program, engineering students are chosen to work on industry toxics use reduction projects after first being introduced to the concept in a three-day training course. Since the program began three years ago, thirteen students have worked as inTURns.



UMass Lowell chemical engineering student Elisabeth Abraham checks the control box of the wastewater treatment system at the Yoplait-Columbo plant in Methuen under the Institute's Student InTURn Program.

Companies Participating in the 1998 InTURn Program

M/A-COM, Lowell

ASTRA USA, Westborough

WALBAR METALS, Peabody

L.E. MASON CO., Boston

BUTCHER CO., Marlborough

Developing TUR Research Capacity at University of Massachusetts Lowell

TURI Research Fellow and Mechanical Engineering student Dennis Gagne worked with Professor Sammy Shina studying the feasibility of additive technologies for the printed wiring board industry. His research has translated directly into his first job at Hadco Corporation, where he has been chosen to implement a new process and product line using conductive ink for the plugging of via holes.

"It is an unusual occurrence for a new hire fresh from school to be sought out for advice by established engineers."

Wendy Daszuta, Process Engineering Manager, Hadco Corporation

University Research in Sustainable Technologies

Sustainable Production of Alternative-Fueled Buses

Enzyme-Catalyzed Modification of Soy Proteins for Cleaning and Emulsion Stabilization

Alternatives to PVC in Medical Applications

Battery-Powered Solid State Cooler/Heater

Fine Pitch Circuit Lines for Additive Technologies in Printed Wiring Board Fabrication

Ultrasonic-Assisted De-inking System for Mixed Office Waste Papers

Green Chemistry: Computational Evaluation of Hydroquinone Non-Covalent Derivatives

Hansen-Type Hydrogen-Bonding Solubility Parameters in Textile Sciences

In the Manufacturing Research Laboratory at UMass Lowell, TURI research associate Liz Harriman (*right*) examines a new additive technology application for printed wiring board fabrication with Prof. Sammy Shina and TURI research fellow and graduate student Valquirio Carvalho of the Department of Mechanical Engineering.

TURI Supports Technical Research

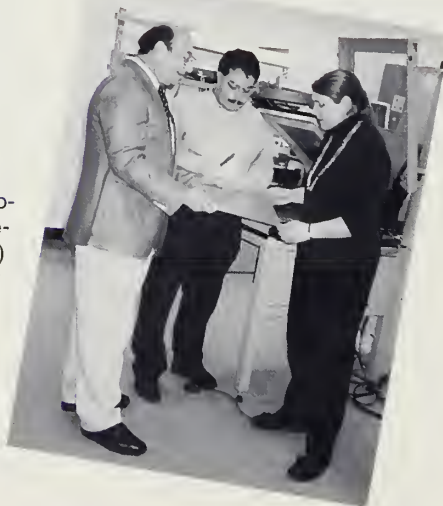
The Institute has sponsored a wide range of research projects on new technologies and materials. With the objective of making that research immediately applicable to Massachusetts businesses, the Institute has developed research partnerships with local firms under its Matching Grants Program.

In addition, the Institute has sponsored more basic research through its Research Fellows and University Research in Sustainable Technologies Programs that support university students and faculty in carrying out year-long studies of sustainable technologies that are environmentally, occupationally, and economically sound. Industry partners provide guidance, propose applications for new technologies, and, in some cases, evaluate and/or adopt processes and technologies resulting from research.

Research Associate Liz Harriman's training in hazardous materials management has prepared her well for technical research in

toxics use reduction. "The Institute supports

industry's efforts to test new cleaner technologies in their facilities, and has created capacity at the University, both with faculty and students, to develop the cleaner technologies of the future."



Making Cleaning Greener in Massachusetts

In 1993 the Institute established a special Surface Cleaning Laboratory to help Massachusetts metalworking, electronics, computer, and automotive manufacturers find environmentally sound alternatives to hazardous industrial cleaning processes.

The only university-based facility of its kind in the nation, the Lab works closely with plant personnel to meet the specific needs of each firm. According to Carole LeBlanc, the Laboratory's manager, each application is different, requiring its own combination of cleaning chemistry and equipment, determined by the Lab's testing. "The really difficult task is matching a proficient, greener cleaning process to a cleanliness inspection tool for quality control," she explains. "We've been successful in identifying alternative cleaning options for over 90 percent of the companies we've assisted."

Without divulging proprietary manufacturing information, the Surface Cleaning Lab helps industries develop and test new technologies and, therefore, promote technology innovation. To further advance this effort, Jason Marshall, the Laboratory's technician, has compiled the results of hundreds of effective cleaning trials into a database. The database is searchable by substrate, contaminant, mechanical energy, and chemical vendor. Jason says, "It's one more resource to speed up the search for safer substitutes to toxic solvents."



Surface Cleaning Laboratory Manager Carole LeBlanc monitors an aqueous cleaning bath.

Companies that have used the Surface Cleaning Laboratory

Wyman-Gordon
ITW Devcon Corporation
Commonwealth Sprague
CR Bard
Osmun Brass
Astron
Light Metal Plating
Erving Paper Mill
MicroE
AW Chesterton
Plating for Electronics
The Trilap Company
Springfield Wire
Lunt Silversmith
Blue Star Technology
Stick II Products
Ferguson Perforating
Radar Technology
Raffi & Swanson Inc.
K&M Electronics
MKS
Milestone
C&K Components
Stafford Manufacturing Company
Redox Technology
Modu Form
Munters Cargo Caire, Inc.
Berkshire Industries
Beloit
Raytheon
Energy Sciences
Global Recycling Technologies
Eastern Reproduction Corporation
Data Con
Webster Lens Company
Duralectra

Winfield Brooks Company
Morgan Construction Company
CR Bard
Lab Medical Engineering and Manufacturing
Northeast Display Inc.
Diamond Machining Technology
Bridgestone/Firestone
Simplex/GEI Consulting
Matheson
Chelsea Center for Recycling
Paramount Tool
Harmonic Drive Technologies
Fraen Corp.
Morton International
Opticoat Associates
Merlin
ARK-LES
Alpha
Hughes
ITT Conoflow
Surmet
Osram Sylvania
OTA
Mass Highway District 3
Micro Engineering
US Polychem
TNRCC Office of Pollution Prevention & Recycling
EG&G
Market Forge
Parker-Nichols
Plastek Inc.
Particle Size Technology
ADTEC Electroplating

A. W. Chesterton, Groveland, Mass. manufacturer of epoxy resins and curing agents

Before: Used a mixture of hazardous solvents—methanol, xylene and methyl ethyl ketone—for cleaning resin-mixing equipment.

After: Switched to water-based cleaning using manual scrubbing and low-pressure spray equipment.

"I would like to express my thanks to you . . . for providing excellent service. This problem confronted by us involved work with some very important customers and the rapid turnaround by you and your staff allowed us to serve them just as quickly." *Andrew J. Finn, A. W. Chesterton Co., Stoneham, MA*

The Technology Transfer Center

"This is incredible! You have assembled right here what would take me weeks to find in my library!"

Visitor to the TTC

The Technology Transfer Center (TTC) has one of the nation's largest collections of publications on environmentally friendly materials and technologies. As a research library and a clearinghouse for publications and articles issued by the Toxics Use Reduction Institute, it is a resource for industry, government, municipalities, and citizens, as well as university students, faculty, and staff. The

Center maintains a collection of over 20,000 books, conference proceedings, and technical papers, a searchable database of more than 7,500 bibliographic records, and subscriptions to more than 100 journals and newsletters.

Janet Clark, the manager of the TTC, has made it a personal mission to acquire the most interesting and useful books, reports, and journals covering a wide range of industrial sectors, and welcomes inquiries by phone, through the Web, or in person.

"The TTC is organized for easy searching and is fully staffed with skillful information professionals," she points out. "Visitors and call-in patrons have expressed clear appreciation for support in their process improvement projects, technology research, or professional development."



High school students working with the South Cove Community Health Center, Boston, under Toxics Use Reduction Networking (TURN) grant, learn how to use the resources of TURI's research library for their project to raise the Asian community's awareness about environmental hazards.

WEB Resources at TURI

TURI
<http://www.turi.org>

P2GEMS
<http://www.turi.org/P2GEMS>

Surface Cleaning Lab
<http://www.cleaning.org>

TURI Sponsors Community Education and Outreach

Another critical mandate for the Institute was educating citizens, community groups and municipal agencies about toxics use reduction. One of the means used to meet that mandate is a grants program.

The Community Education Program in Toxics Use Reduction was designed to acquaint the public with the concept of toxics use reduction and the Massachusetts Toxics Use Reduction Program, and to assist the public in learning how to access and use toxics use reduction information. The Program includes the Toxics Use Reduction Networking (TURN) Grants program comprising specifically designed education and training initiatives for citizens, local governments and municipalities, as well as an environmental leaders forum. This program was intended to foster partnerships between local community groups, local government agencies, and local companies to promote and develop mutually beneficial pollution prevention activities and more sustainable economies and environments across the state.

The Institute has awarded twenty-five TURN grants. The success of this community-based program and that of the cleaner technology demonstration site program for industry, and the willingness of participants in both to work together on projects have generated ideas for the development of future toxics use reduction demonstration communities.

Community Education under the TURN Grants Program

Community Awareness Projects

Bowdoin Street Health Center
Clean Water Fund
Massachusetts Campaign to Clean Up Hazardous Waste
Massachusetts Coalition for Occupational Safety and Health
Green Decade Coalition
John Snow Institute, Center for Environmental Health Studies
Lawrence Grassroots Initiative
Massachusetts Alliance of Portuguese Speakers
Independent Laundry Workers Union, Local 66L
Regional Environmental Council of Central Massachusetts
Western Mass Coalition for Occupational Safety and Health
South Cove Community Health Center

Municipal Intergration Projects

Boston Police Department
Center for Ecological Technology
Massachusetts Fire District 14
Northampton Board of Health
Springfield Local Emergency Planning Committee
Franklin County Solid Waste Management District
Lexington Health Department
Massachusetts Health Officers Association
Massachusetts Public Interest Research Group

PROJECTS AND PARTNERS



UMass Lowell graduate students, Hans-Christoph Schwarzer (chemical engineering), *left*, and Valquirio Carvalho (mechanical engineering), compare traditional solvent-based paint finishes with newer, less toxic powder-coated alternatives during their summer inTURNship with M/A-COM at the electronics firm's Lowell facility.



Auto body shop owners with police and participants from city and state health and environmental agencies at one of a series of Toxics Use Reduction workshops hosted by Boston Police District E-18 under a TURN grant.

Cleaner Technology Demonstration Sites, 1996-1997

- Leach & Garner Company**, General Findings
Division, North Attleboro
Ammonia Reduction for Heat Treat Furnace Atmospheres
- Lockheed Martin Defense Systems**, Pittsfield
Design for the Environment Workshops
- Ocean Spray Cranberries, Inc.**, Middleboro
Elimination of Cooling Tower Chemical Additives
- Parlex Corporation**, Methuen
Innovations in Toxics Use Reduction in Printed Wiring Board Manufacture
- Tri-Star Technologies Company, Inc.**, Methuen
Cupric Chloride Etch Regeneration
- Cranston Print Works**, Webster
Process Improvement, Substitution & Integral Recycling
- Danaher Tool Group**, Springfield
Nitric Acid Recovery Using Diffusion Dialysis
- Lockheed Martin Defense Systems**, Pittsfield
Aqueous Cleaning of Mechanical Parts
- Metallized Products, Inc.**, Winchester
Electron Beam Curing of Polymers in Coating Processes
- Utopia Cleaners, Arlington**
Garment Wet Cleaning

Industry Matching Grants 1993-1996

- Malden Mills Corporation**, Lawrence
Reduction and Possible Elimination of Acetic Acid Use in the Disperse Dyeing of Textiles
- Raffi & Swanson, Inc.**, Wilmington
Cleaning Alternatives for Adhesives and Coatings Process Reactors
- M/A-COM**, Lowell
Toxics Use Reduction and Design for the Environment in the Electronics Industry
- Commonwealth Sprague Capacitor, Inc.**, North Adams
Aqueous Degreasing for Electronic Components Manufacturing
- Dav-Tech Plating, Inc.**, Marlborough
Electrodialysis for Integral Recycling of Electroless Nickel Baths
- Printed Circuit Corporation**, Woburn
Reclamation of Nitric Acid from Solder Strip
- M/A-COM**, Lowell
Integrating Design for the Environment and Toxics Use Reduction Principles into the R&D Process
- Consortium of six metal forming companies**
Closed-Loop Aqueous Cleaning Systems and Alternative Lubricants for Metal Forming
- Beloit Fiber Systems**, Dalton
Alternative Equipment for Bulk Degreasing and Abrasive Blasting Operations
- M/A-COM**, Lowell
Elimination of Ozone-Depleting Chemicals
- M/A-COM Semiconductor Products Division**, Burlington
Alternatives to Arsine in Arsenic Ion Implantation

Northrop, Electronics Systems Division,
Norwood
Elimination of Cyanide-Based Electroplating

Plastic Distributing Corporation, Ayer
Alternative Refrigerants for Industrial Chillers

Smith & Wesson, Springfield
Water-Based Polymer Coating to Replace Nickel Pentrate and Anodized Coatings

Smith & Wesson, Springfield
VOC Lacquer Replacement

Texas Instruments, Inc., Materials and Controls Group, Attleboro
Supercritical Fluid Extraction Cleaner Evaluation

The Robbins Company, Attleboro
Reduction of Cyanide Use in Electrolytic Cyanide Stripping



Karen Thomas, TURI research associate, left, and Pattie Wolfhope, a technician at M/A-COM, check the finish of a uv-curable conformal coating, a new process that will eliminate VOCs from the current conformal coatings used on products manufactured by the Lowell-based electronics firm, one of the Institute's 1998 Cleaner Technology Demonstration Sites.

University Research Fellows Projects 1992-1997

Evaluation of Additive Technologies in the Printed Circuit Board Industry
Dennis Gagne, Prof. Sammy Shina, Mechanical Engineering Dept.

Development and Testing of P₂/OASys - The Pollution Prevention Options Assessment System
Alexandra Gonzalez, Prof. Michael Ellenbecker, Work Environment Dept.

Surface Cleaning Research
Ramesh Sethuraman, Prof. Michael Ellenbecker, Work Environment Dept.

Implementation of "No Clean" Solder for Ultra-Fine Pitch Surface Mount Technology
Doug Sommer, Prof. Sammy Shina, Mechanical Engineering Dept.

Development of a Substitution Analysis Methodology for Small- and Medium-Sized Companies
Joel Tickner, Prof. David Kriebel, Work Environment Dept.

"Closing the Loop," A Guide to the Recycling and Reuse of Aqueous Cleaners
Chris Underwood, Prof. Al Donatelli, Dept. of Chemical Engineering

Impact Analysis of Pesticide Bans
Beth Rosenberg, Prof. Charles Levenstein, Work Environment Dept.

Application of TUR Approaches to OSHA Policy
Jennifer Penney, Prof. Rafael Moure-Eraso, Work Environment Dept.

The Use of Supercritical Fluids as Substitutes for Dry Cleaning Solvents: Evaluation of Enzyme Activity for Stain Removal
Fu-Jung Kao, Prof. Samuel P. Sawan, Dept. of Chemistry

"No-Clean" Soldering in Electronics Manufacturing

Paul F. Hailey, Prof. Sammy G. Shina, Mechanical Engineering Dept.

Design for Environment Metrics and Fuzzy Logic

Michael Reinhardt, Prof. John Duffy, Mechanical Engineering Dept.

TURA Data Analysis

Donald LaTourette, Prof. Michael Ellenbecker, Work Environment Dept.

Proposal for Formaldehyde Use Reduction in Mortuaries and Anatomy Laboratories

Chengchen Mao, Prof. Susan Woskie, Work Environment Dept.

The Use of Supercritical Fluids as Substitutes for Cleaning Solvents: Interaction with Polymeric Materials and Adhesives

Yeong-Tarng Shieh, Jan-Hon Su, Fu-Jung Kao, Prof. Samuel P. Sawan, Dept. of Chemistry

Non-Volatile Precursors to Olefinic Bromofluorocarbons as Alternative Fire-Extinguishing Agents

Kenneth Moore, Venkataramani Shivshankar, Alec Crawford, Prof. William W. Bannister and Edwin G. E. Jahngen, Dept. of Chemistry

Solvent Use Reduction Technologies: Macromeric Surfactants in Emulsion Polymerization Systems

Savvas Hadjikyriacou, Prof. Rudolf Faust, Dept. of Chemistry

A Biological Process to Make Environmentally Friendly Water-Soluble Ionic Polymers

Feng Ying Shi, Ann Marie Cromwick, Prof. Richard A. Gross, Dept. of Chemistry

Biological Synthesis of Chemicals and Materials: Biological Synthesis of 4,5-dihydroxyphthalate as an Intermediate to Para Polyphthalene

Chin-Long Wu, Mike Dango, Devon Genus, Prof. Carl W. Lawton, Dept. of Chemical Engineering

Life Cycle Analysis: Petrochemical Synthesis Versus Biological Synthesis of Polymers

Frances A. Eagle, Prof. Stephen McCarthy, Plastics Engineering Dept.

Synthesis of Silicon Carbide Fibers

Steve Mullin, Prof. Joseph Milstein, Electrical Engineering Dept.; Prof. Thomas Vasilos, Chemical and Nuclear Engineering Dept.

Companies Participating in the InTURN Program 1996-1997

Acushnet Rubber Company, Inc., New Bedford
K&M Electronics, Inc., West Springfield
Adtec Electroplating, Lawrence
Raytheon Electronic Systems, Lexington
Yoplait-Columbo, Methuen
M/A-COM, Lowell
Astra USA, Westborough

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